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Fundamentals of rotating fluidized beds and application to particle separation

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Driving Innovation ♦ Delivering Results



Fundamentals of rotating fluidized beds and application to particle separation

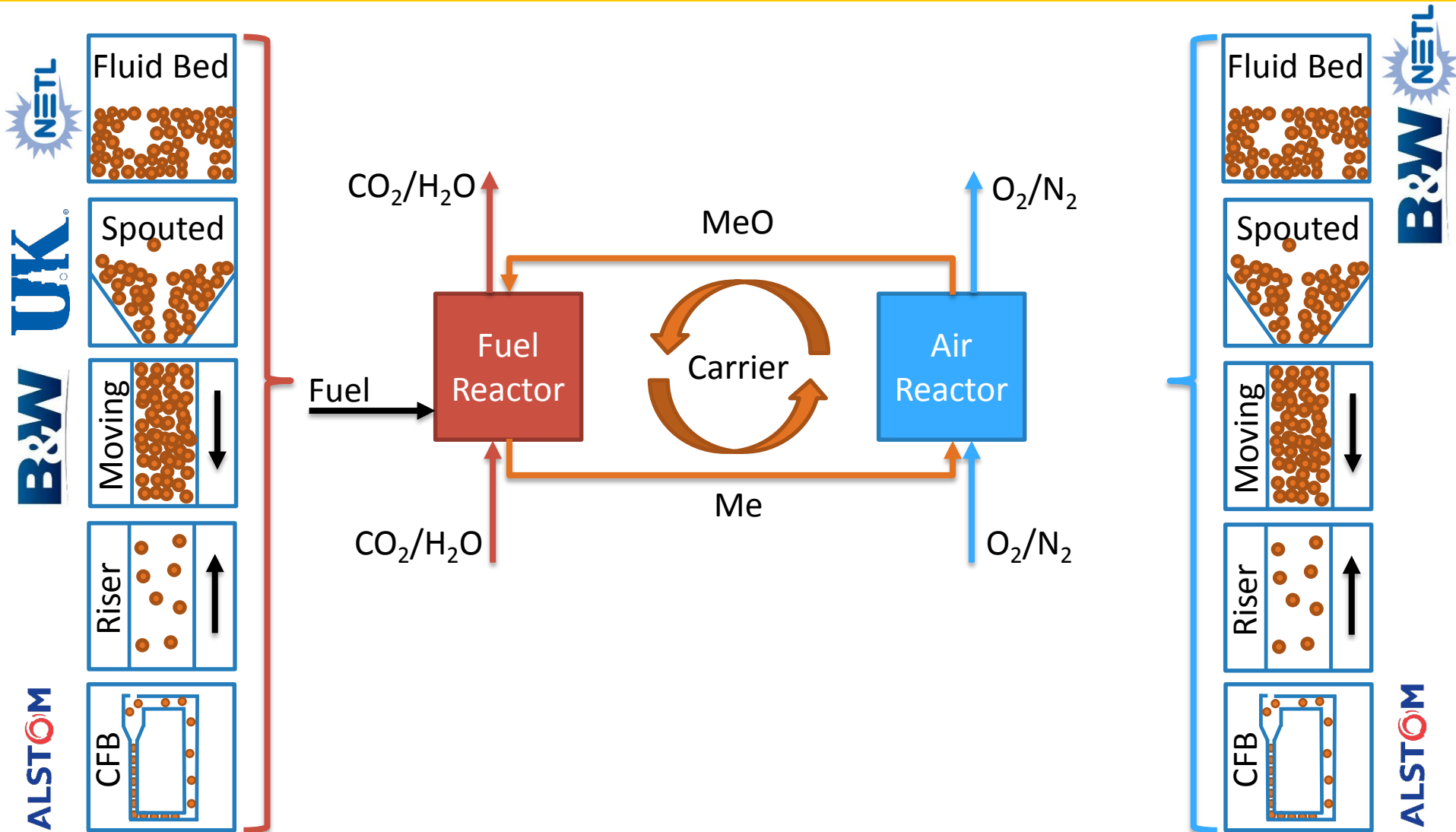
Justin Weber, Richard Stehle,
Ronald Breault, Juray DeWilde



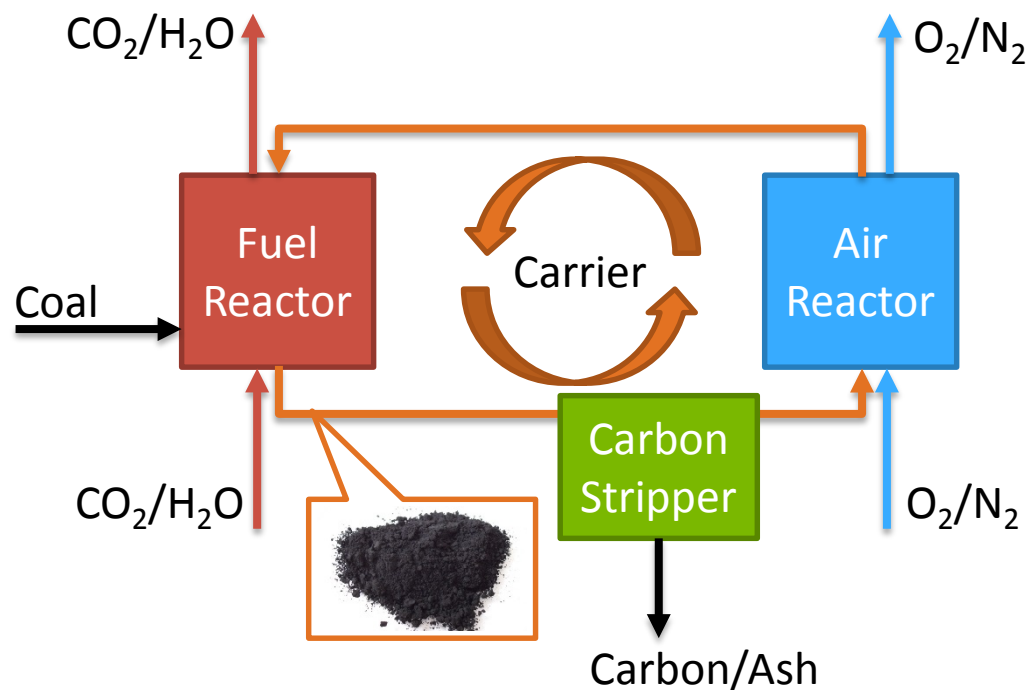
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Technology Laboratory

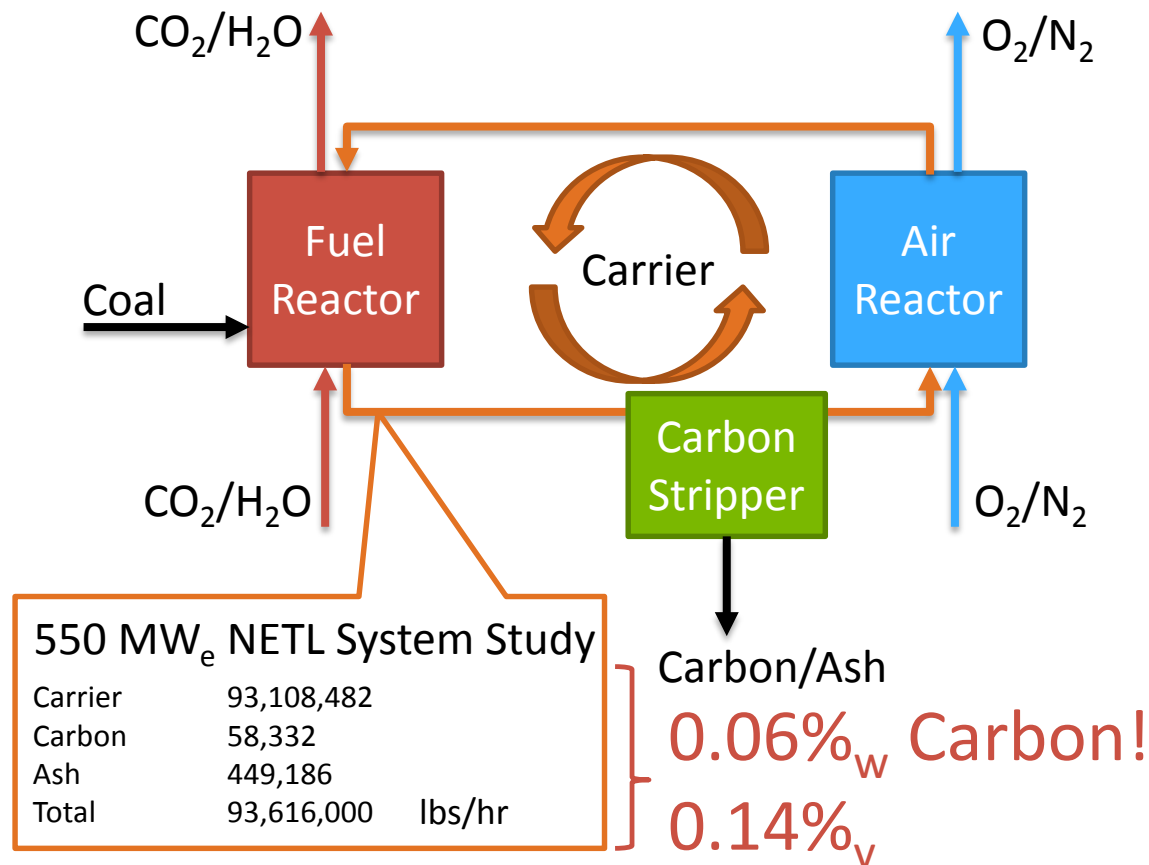
Typical Chemical Looping Process



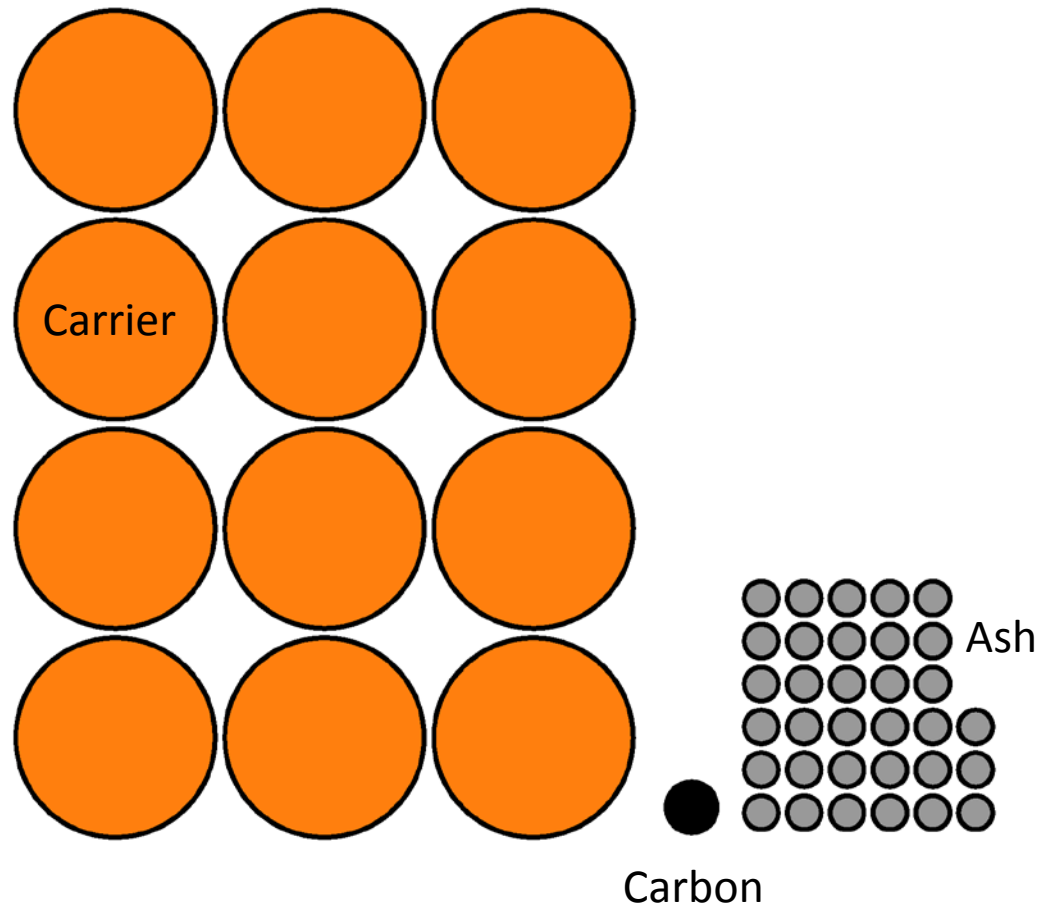
The Problem: Solid Fuels



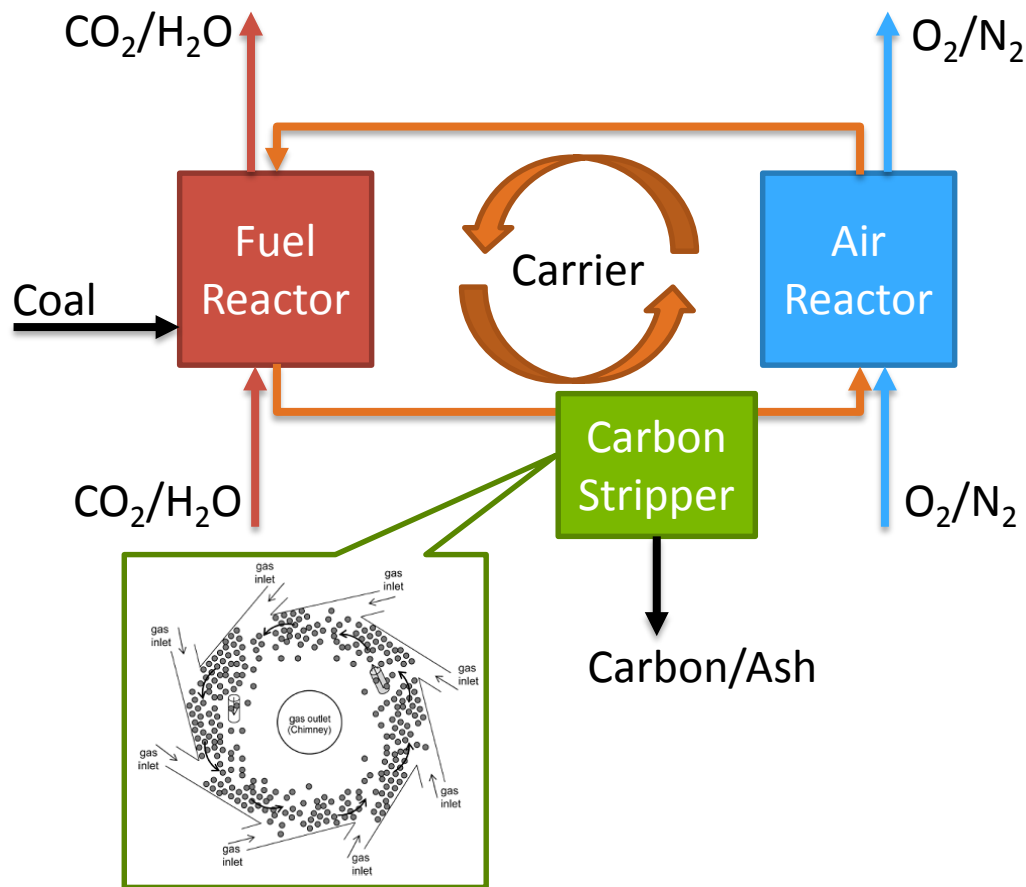
Let's put some numbers on it!



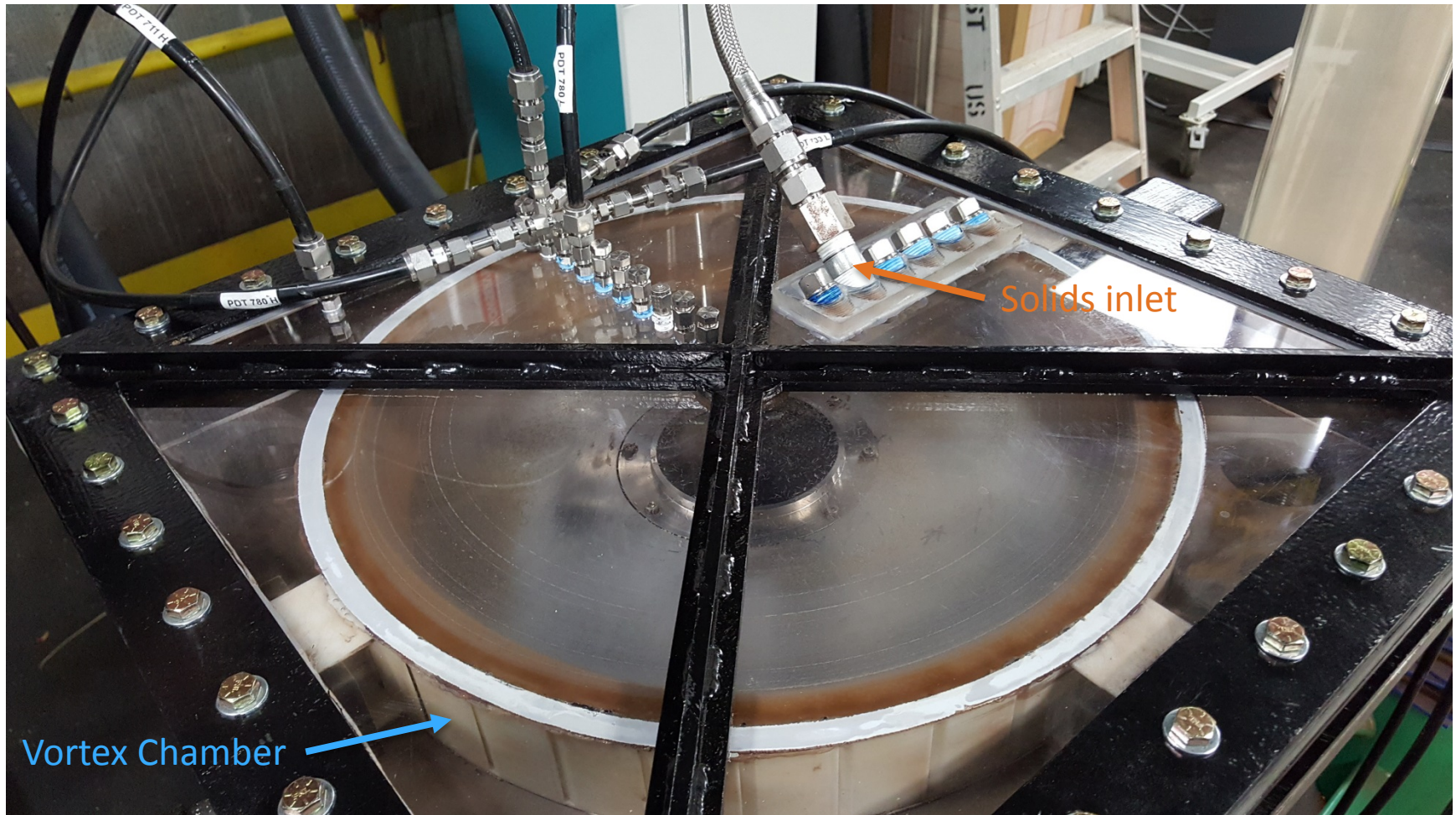
Lets put it into perspective



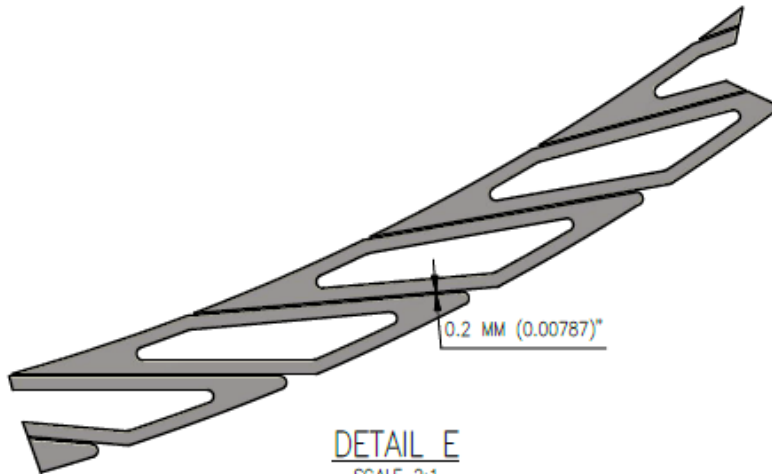
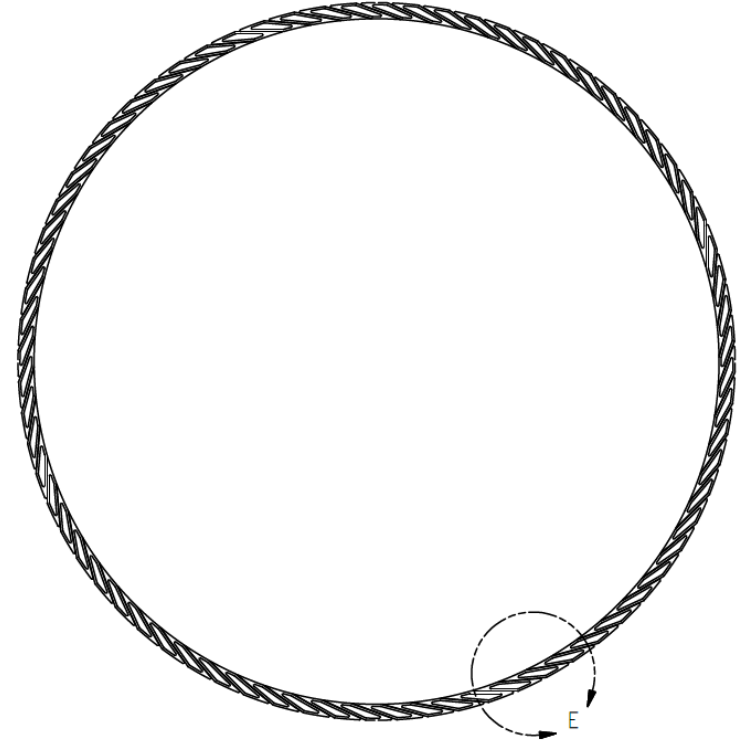
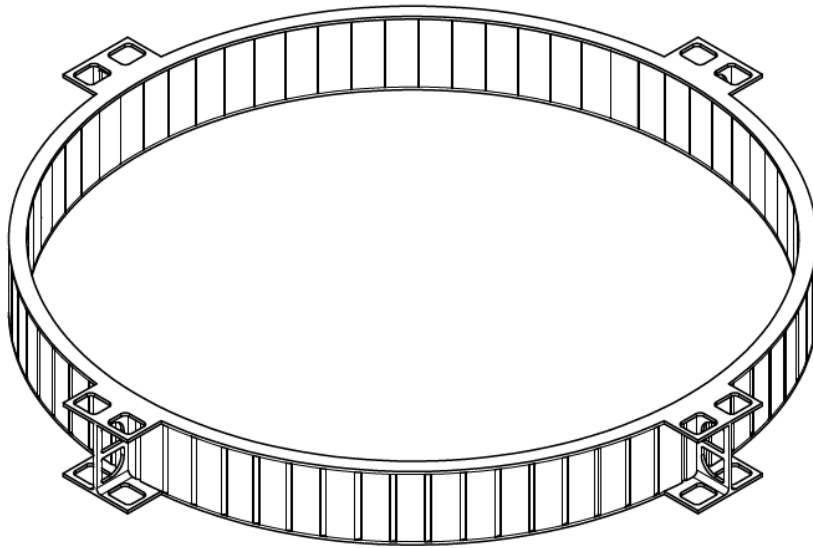
Rotating Fluid Bed as a Separator?



Experiment



3D printed vortex chamber



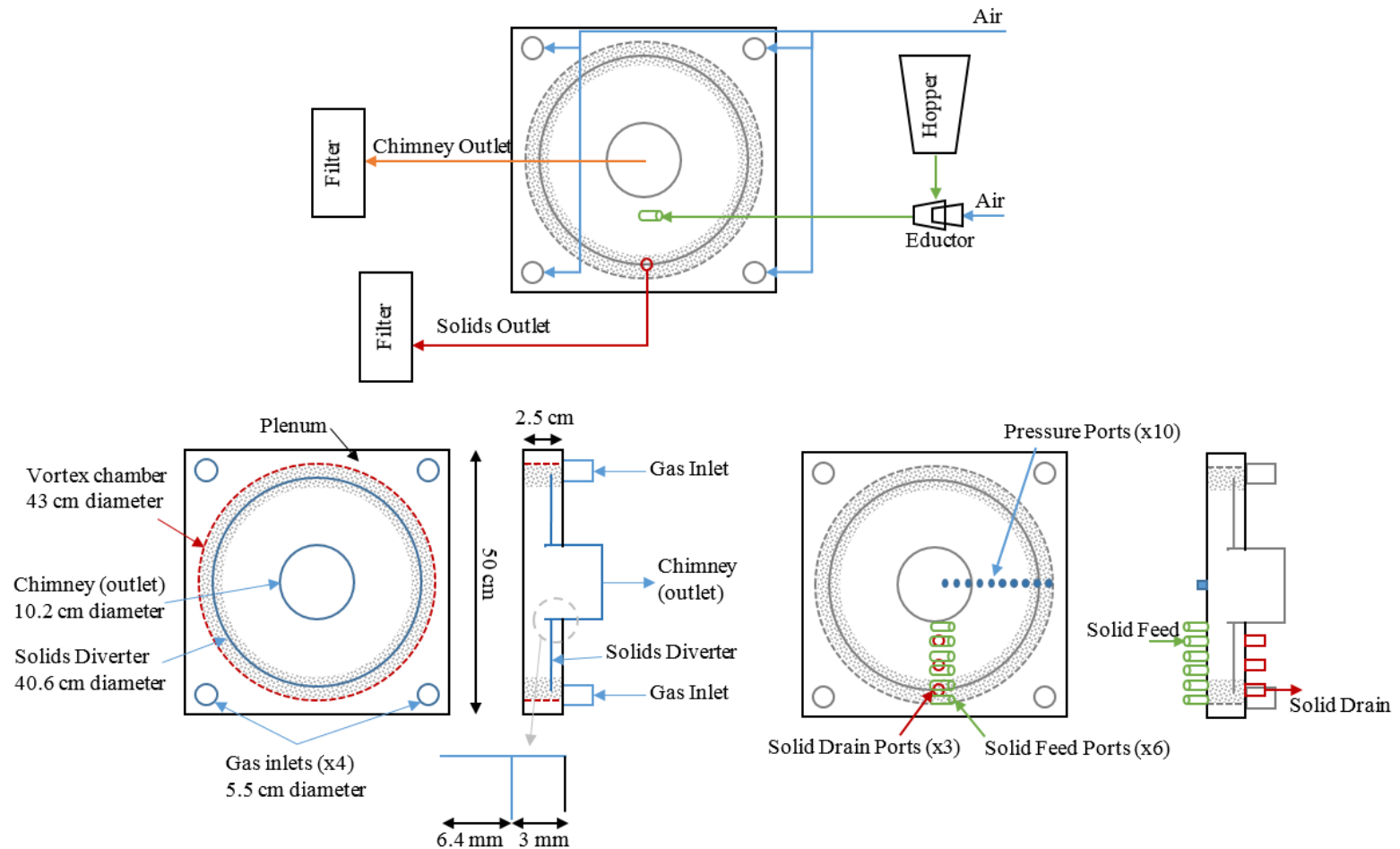
DETAIL E
SCALE 2:1

38, 0.381mm slots
25 cm thick
12G – 59G

3D printed vortex chamber



System Layout



Solid-Solid Separation



	density	d_{SMD}	d_{50}	sphericity	U_{mf}	particle mass
Material	g/cm ³	μm	μm		cm/s	mg
High Density Polyethylene	0.86	871	885	0.92	17.4	0.312
Glass Beads	2.51	329	333	0.92	9.47	0.049
Cork	0.19	797	835	0.8	9.37	0.058

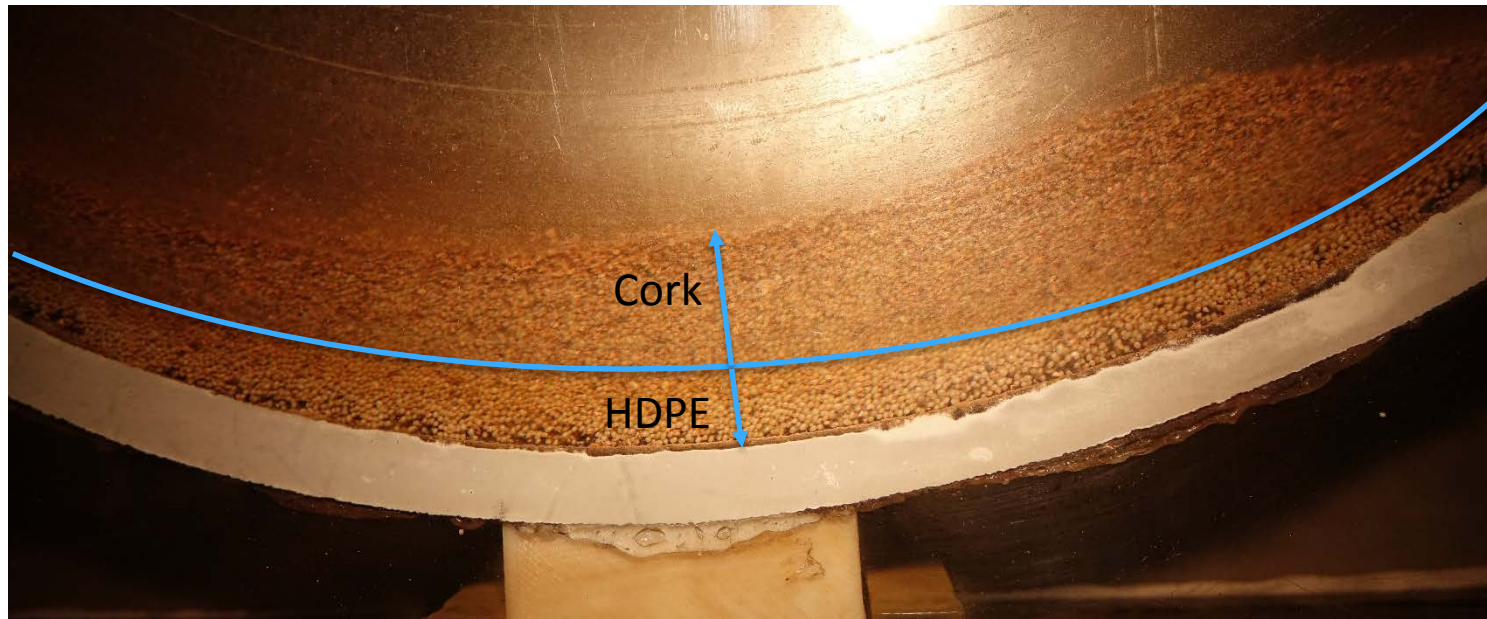
Centrifugal Force:

- Particle mass dependent
- Force directed radially outward

Drag Force:

- Particle size dependent
- Force directed radially inward

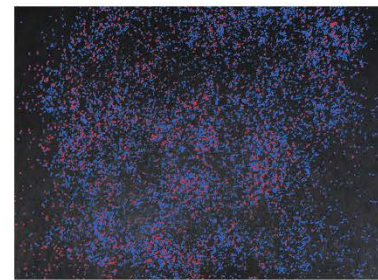
Separated solids!



HDPE and Cork Separation



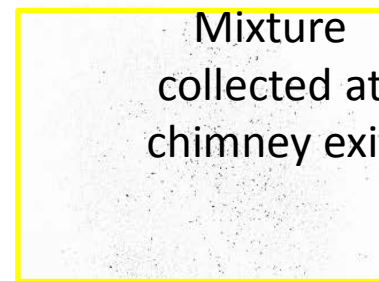
Mixture feed
at inlet



20% HDPE
by particle
count



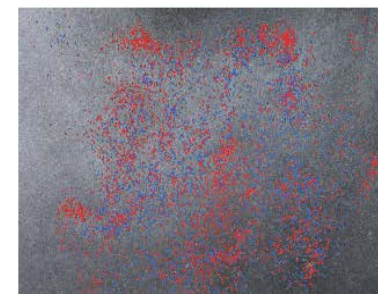
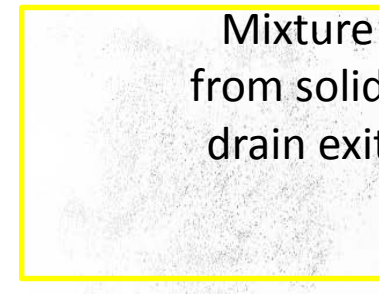
Mixture
collected at
chimney exit



98% cork
by particle
count



Mixture
from solids
drain exit

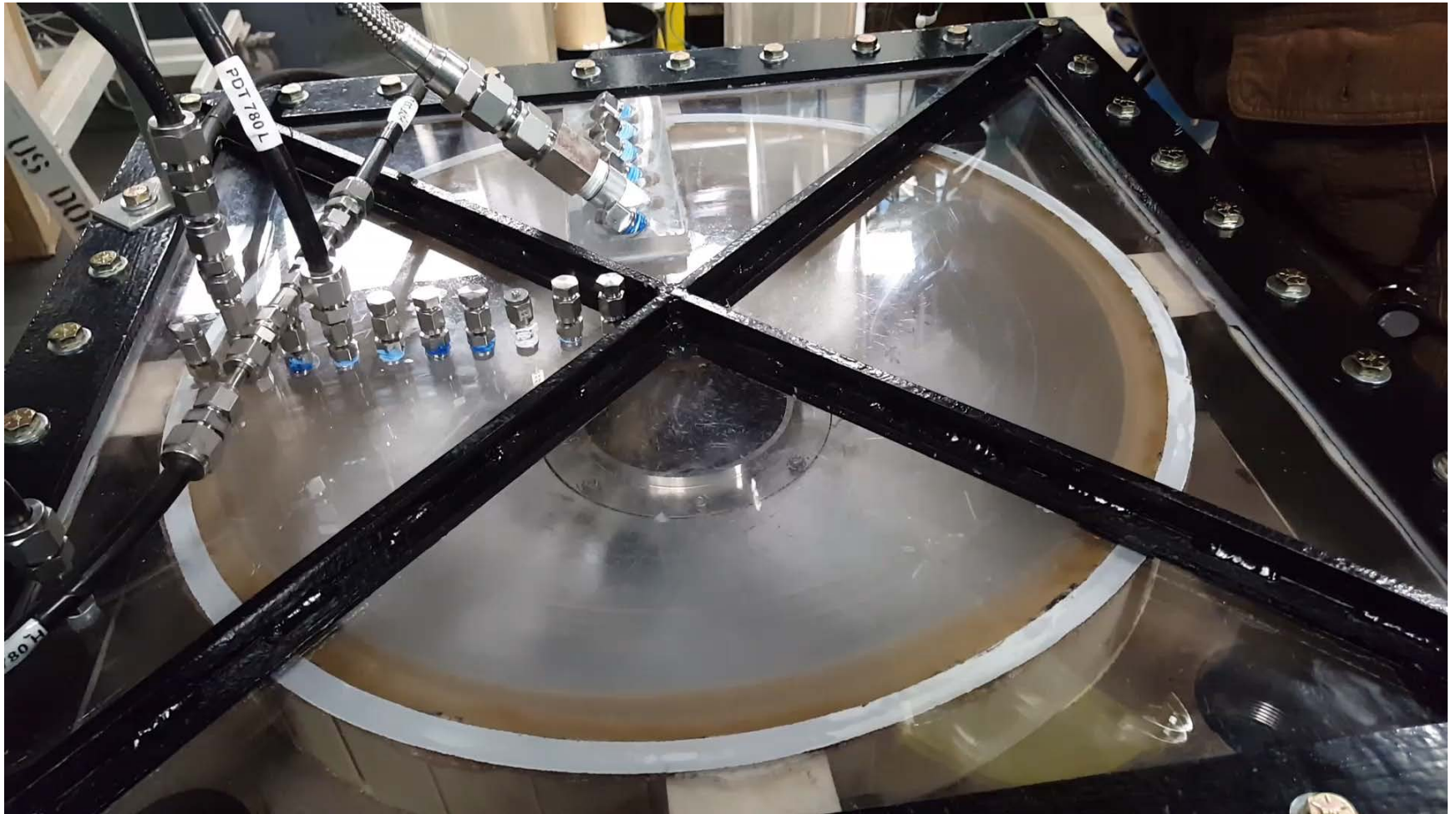


55% HDPE
by particle
count

***Glass Beads and HDPE did not separate**

Slugging





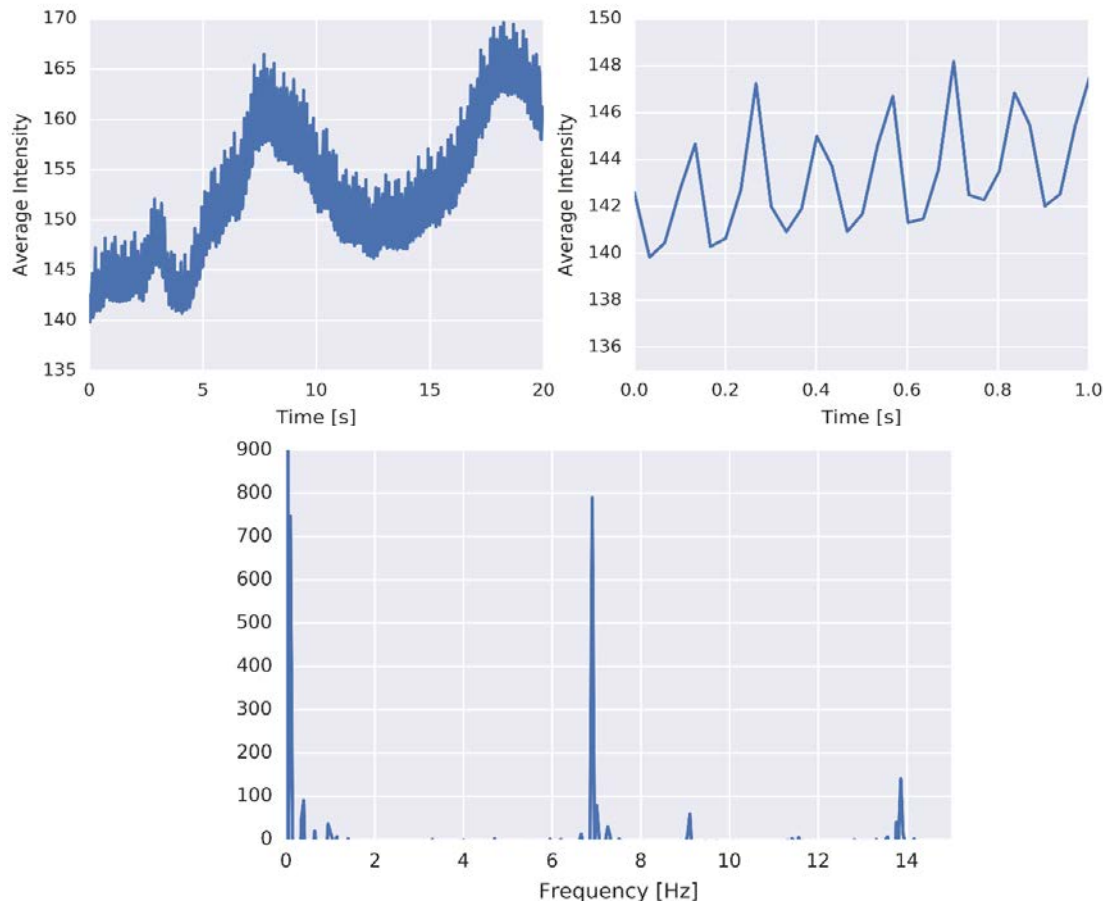
Video of slugging



Particle Velocity



High Speed Video Analysis



Tangential velocity of 9.4m/s at a radius of 21.5cm; 45g

Drag vs Centrifugal Forces



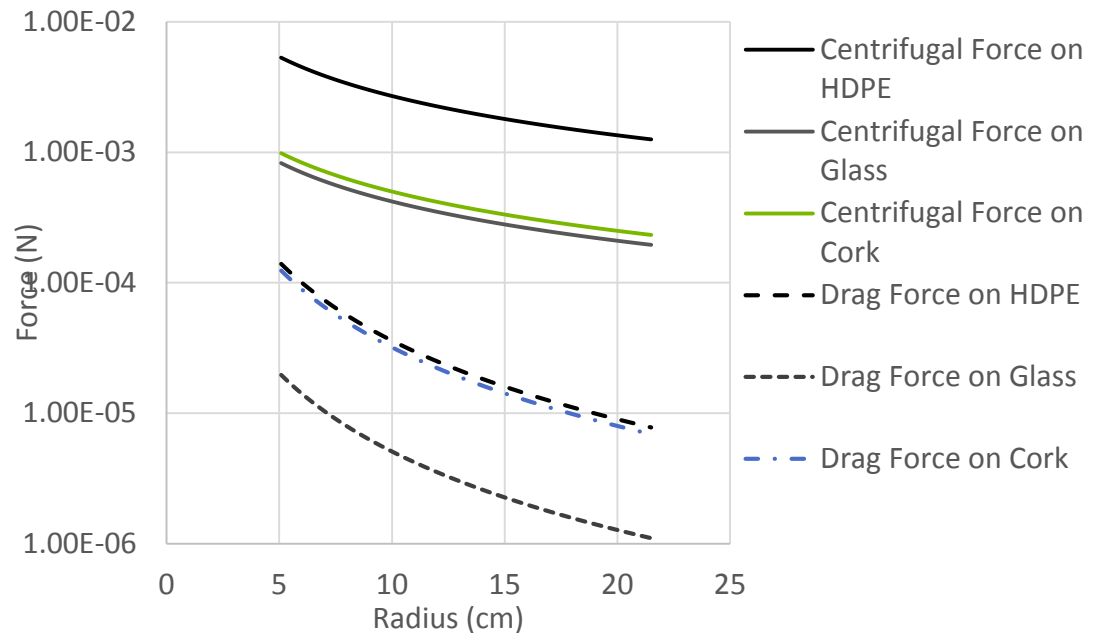
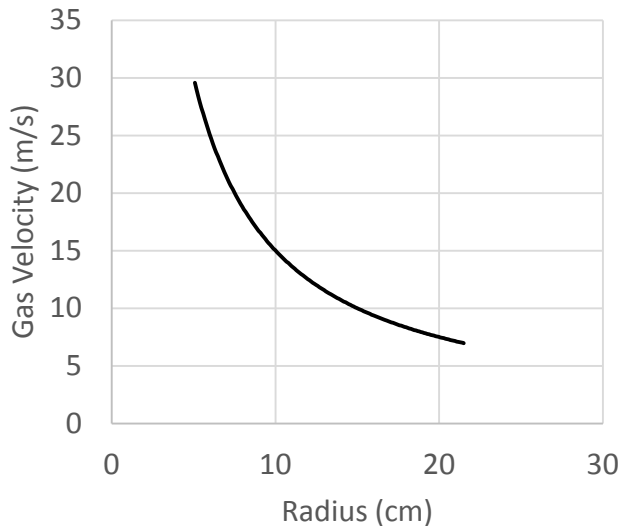
Radial Gas Velocity:

Air volumetric flow rate 30,000 SCFH

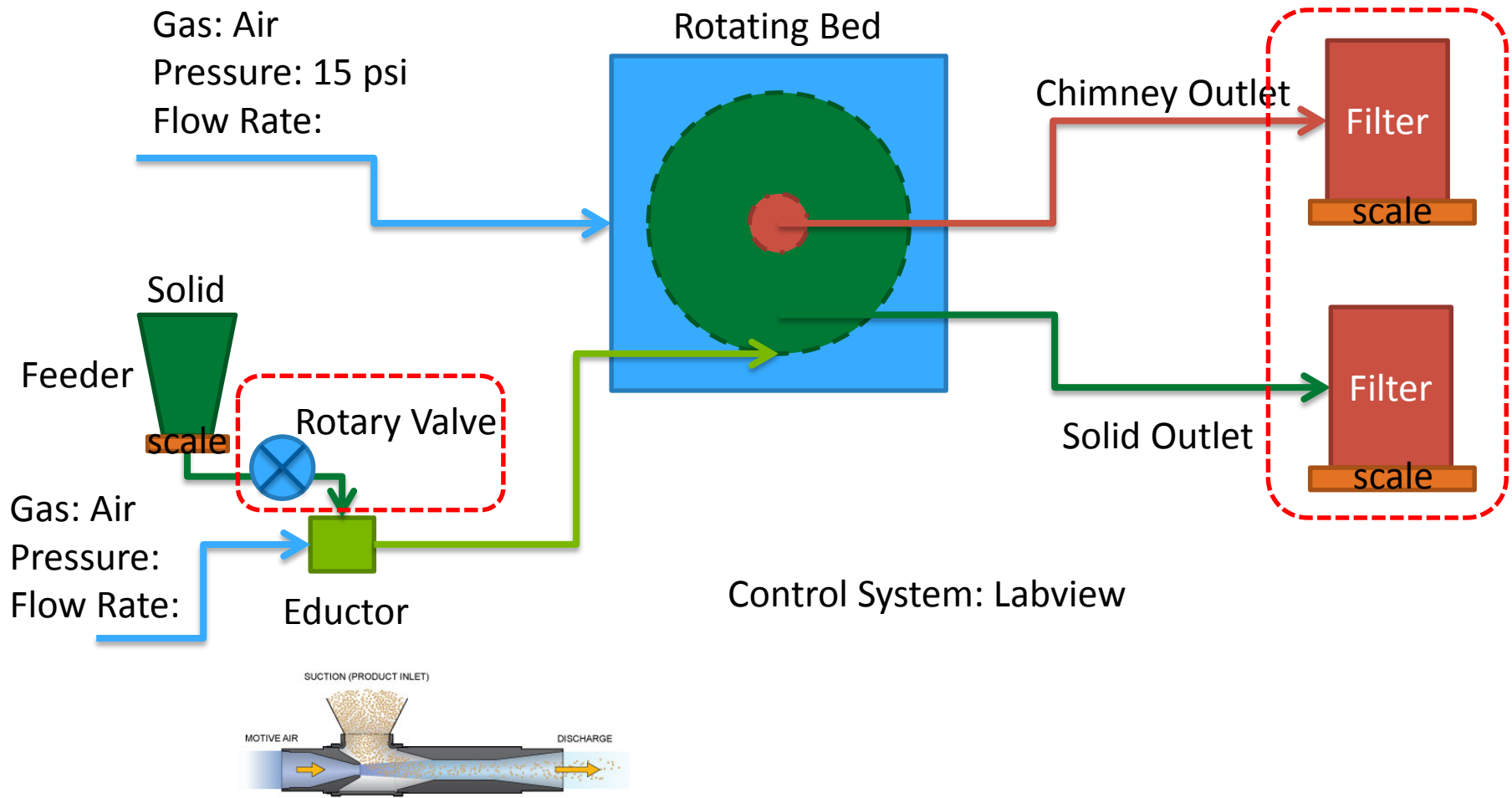
or

236,000 cc/s

$$F_{c,p} = \frac{m_p v_{t,p}^2}{r} \quad F_{d,p} = \frac{1}{2} \rho_g v_{r,g}^2 C_D A_p$$



Continued Work



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